THE FOREST FIRE

A BASIC GUIDE TO FIRE BEHAVIOUR AND SUPPRESSION

Province of British Columbia
Ministry of Forests

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William Young

Chief Forester
Ministry of Forests

FIRE BEHAVIOUR

CAUSES OF FOREST FIRES

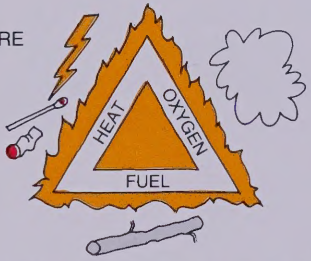
There are more than 2,500 wild fires every year in British Columbia. The Ministry of Forests Protection Branch calculates that lightning causes 37 per cent, industrial activity such as logging causes 25 per cent, and the people who use the woods for recreation cause the remaining 38 per cent.

WHY A FIRE BURNS

Successful fire-fighting is based on knowing why a fire burns and what makes it spread. The understanding of this fundamental process will help you do a better job in controlling forest fires.

THE FIRE TRIANGLE
HEAT + OXYGEN + FUEL = FIRE

THE BASIC RULE: REMOVE ONE SIDE OF THE TRIANGLE, AND THE TRIANGLE WILL COLLAPSE; COMBUSTION WILL CEASE AND THE FIRE WILL BE EXTINGUISHED.



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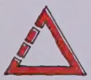
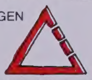
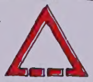
		
THE HEAT COMPONENT CAN BE ELIMINATED BY COOLING THE FIRE WITH WATER OR DIRT.	THE OXYGEN SIDE CAN BE REMOVED BY BURYING BURNING FUELS IN MINERAL SOILS.	THE FUEL SIDE OF THE TRIANGLE CAN BE WEAKENED BY BREAKING UP AND ISOLATING FUELS.

The Fire Triangle

To have a fire, you must have a combination of three things: *fuel*, *oxygen* and *heat*.

In a forest fire, the fuel is the forest, the oxygen comes from the air, and the heat comes from lightning or from man.

If any one of these three elements is missing, there can be no fire. *The basic principle of fire-fighting, therefore, is to remove one or more of these elements in the quickest and most effective way.*

There is no other way to suppress a fire.

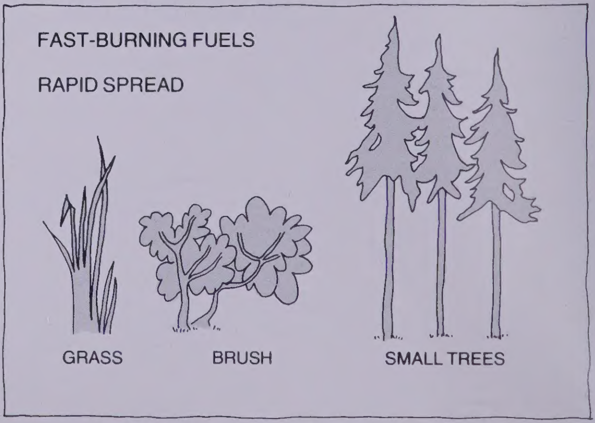
WHY A FIRE SPREADS

The primary factors that influence the spread of fire are *fuels*, *weather* and *topography*.

Fuels

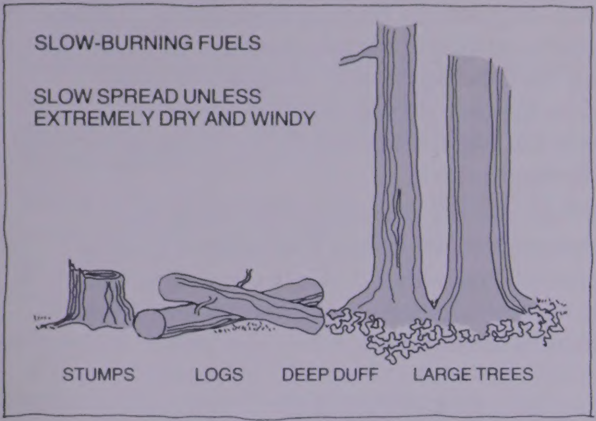
Light and fast-burning fuels

Dry grass, dead leaves and tree needles, brush and small trees. Light fuels cause rapid spread of fire and serve as kindling for heavier fuels. Some green fuels such as tree needles have a high oil content and are fast-burning when they are not in an active growing stage.



Heavy or slow-burning fuels

Logs, stumps, and deep duff (the topsoil or partly decayed leaves and tree needles found under dense stands of brush or trees). Heavy fuels burn readily and throw off large volumes of heat when dry.



Snags

Because of the abnormally high percentage of forest fires which start in snags, they must be placed in their own category. Snags are dryer and always ready for ignition. Fires burning in snags must be controlled promptly through a series of recommended procedures which will be covered later in this course.

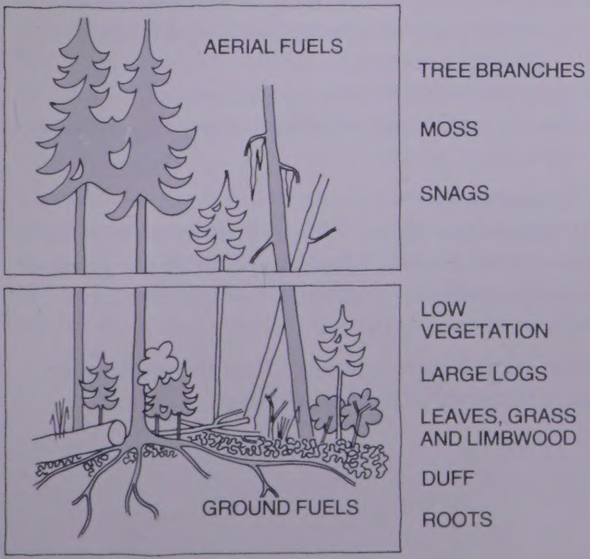
The ease of ignition and rate of burning are influenced by the *size of fuels*.

Small or light fuels

Grass, leaves, tree needles and light brush. These ignite quickly and produce a fire that spreads rapidly and burns out faster.

Large or heavy fuels

Stumps, logs, branch wood and large trees. These take longer to ignite and the fires they create spread slower and burn longer, usually with a greater intensity.

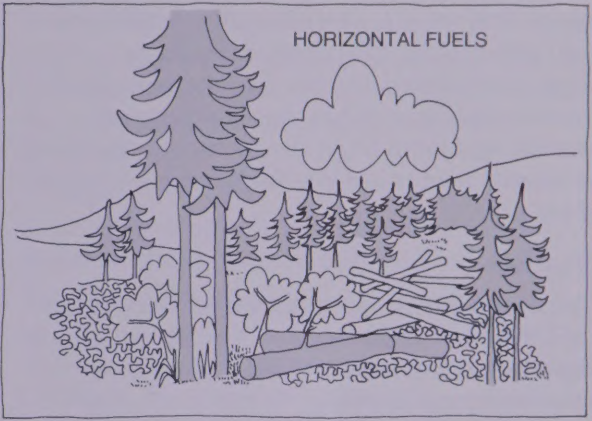


Spacing

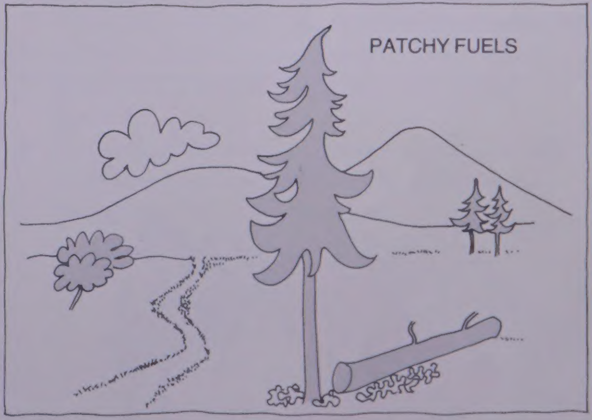
Fuel spacing describes the distribution of fuels in a given area. Fuel continuity is an important factor in the behaviour of fire because it indicates how quickly and to what area a fire may spread.

A wide range of fuel continuity conditions will be found in most forested areas. However, for simplicity in determining fire behaviour, two broad classifications of fuel spacing will be discussed: horizontal and vertical.

Horizontal spacing is the spacing of the fuel as it lies on the ground. When fuels are close together, the fire will spread faster.



When fuels are *patchy*, scattered or separated by natural barriers such as rock outcroppings, streams, or areas of bare ground, the fire will be irregular or spread more slowly.



The most commonly used method of fire suppression is to break the continuity of the fuel by separating burning fuels from unburned fuels. This is called the fireline.

When fuels are closely spaced *vertically*, fire will spread rapidly as the fuels above are pre-heated and ignited.

When fuels are spaced far apart vertically, the heat is not sufficient to ignite the fuels above.

Quantity

As the amount of inflammable material in a given area increases, the amount of heat produced by the fire also increases. The hottest fires, as well as those most difficult to control, occur in areas containing the greatest *quantity of fuel*.

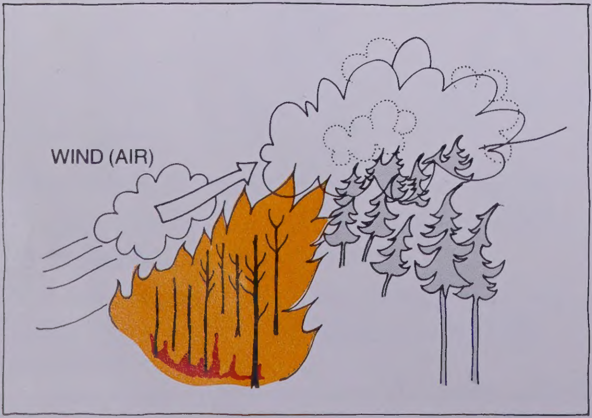
In evaluating fuel volume, it should be noted that a lot of small materials like fine deadwood, means that there is a lot of kindling material to light other fuels. A lot of either small- or large-sized material means that there is a good chance of hot fire. When fires start in areas containing a lot of large-sized material, there will be intense heat transfer to fuels lying in the path of the fire.

Weather

One of the most important factors affecting the behaviour of a fire is *weather*. And the three most important components of weather are *wind*, *temperature* and *humidity*.

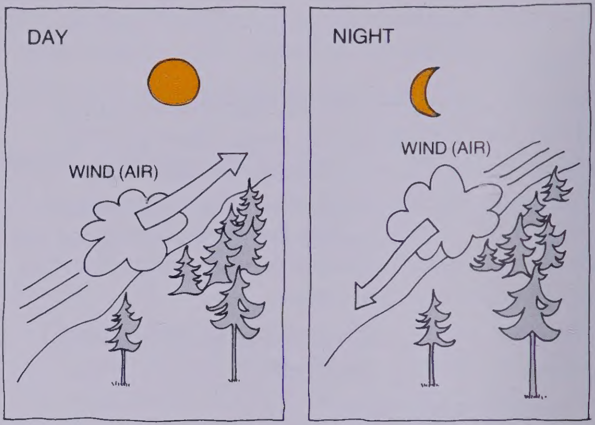
Wind

The stronger the *wind*, the faster the spread of the fire. Wind brings an additional supply of air to the fire. It flattens the flame which pre-heats the fuel ahead, and causes spot fires by blowing sparks and embers ahead of the main fire into a new source of fuel.



Winds generally blow upslope at 5 to 10 miles per hour during the day, because sun-warmed air rises. At night, they reverse and blow downslope, because cooler night air sinks. The wind at night is not usually as strong as the wind during the day.

When you are planning a fire attack, the direction of *canyon and slope winds* should be carefully considered. Air currents flow up a canyon and slope during the day and down during the night



Other wind behaviour characteristics which must be considered:

- prevailing winds usually blow from late morning to late afternoon and may blow at 10 to 20 miles per hour or higher by mid-afternoon;
- cumulus clouds may indicate a possible change in wind speed and direction;
- winds usually flow out from the edge of a thunderstorm and may reach speeds of 70 miles per hour; and
- gusty winds are very hazardous to fire-fighters, because they change speed and direction rapidly.

Temperature

Fuels pre-heated by the sun burn more rapidly than do cold fuels. The *temperature* of the ground also affects the movement of air currents, as explained previously.

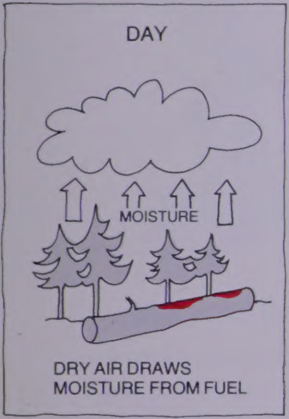
Also, high temperatures reduce the endurance and efficiency of the fire-fighters.

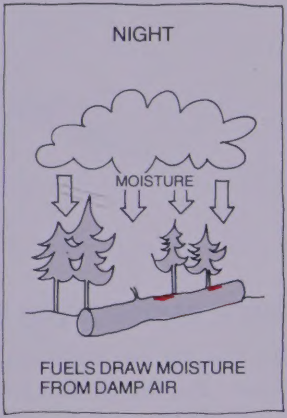
Humidity

Moisture in the form of water vapour is always present in the air. The measurement of that moisture is called *humidity* and is always expressed as a percentage.

Warm air absorbs more moisture and produces a lower humidity. As air cools, the humidity increases.

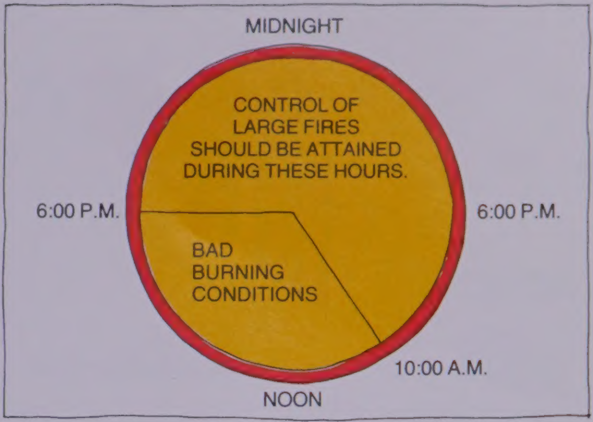
The amount of moisture in the air affects the moisture in the fuel. This is an important factor in fire-fighting, since wet and most green fuels will not burn freely. Air is usually drier during the day than at night. Fires, then, burn more slowly at night, under normal circumstances, because the fuels absorb moisture from the damp night air.





This partially explains why a fire burns out of control in the afternoon and yet may be controlled by the same crew at night. Every effort should be made to control a fire before burning conditions build up the next day. In British Columbia, the goal of all fire-fighters is to control or extinguish any fire by 10:00 a.m. of the following day.

This doesn't mean that an attempt to suppress a fire should not be made during the day. Most fires are controlled during the day. If a fire cannot be controlled during the day, an all-out effort must be made at night.



Topography

The 'lay of the land' is called *topography*. This is an important factor in the rate and direction of fire spread and is usually broken into three categories.

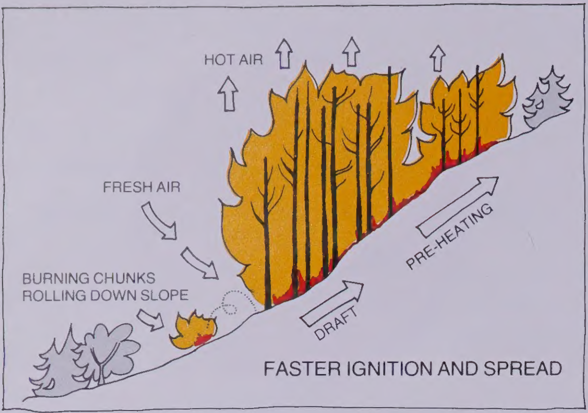
Slope

Slope is the steepness of the land and has the greatest influence on fire behaviour.

The steepness of the slope affects both the rate and direction of the fire spread. Usually fires move faster uphill than downhill. The steeper the slope, the faster the fire will move. This is because:

- on the uphill side, the flames are closer to the fuel;

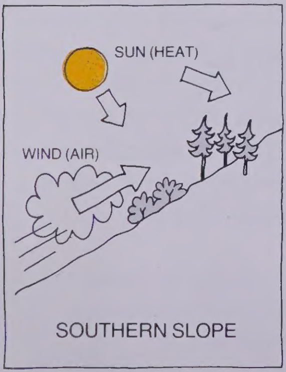
  the fuels become drier and ignite more quickly than if on level ground;
- wind currents are normally uphill and this tends to push heat and flames into new fuels;
- convected heat rising along the slope causes a draft which further increases the rate of spread;
- burning embers and chunks of fuel may roll downhill into unburned fuels, increasing spread and starting new fires.

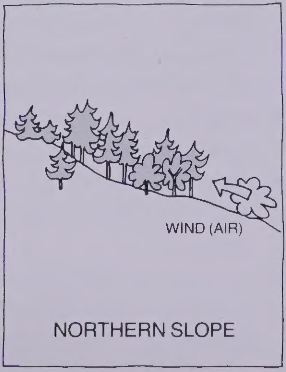


Aspect

Aspect is the direction the land faces whether north, south, east or west. The aspect of a slope influences a fire's behaviour in several ways:

- southern aspects receive more direct heat from the sun, drying both the soil and the vegetation;
- fuels are usually drier and less dense on southern slopes than fuels on northern slopes;
- heating by the sun also causes earlier and stronger slope winds; and
- on south-facing slopes, there will normally be higher temperatures, stronger winds, lower humidities, and lower fuel moistures.





These are all the conditions needed for quick starts and a rapid rate of fire spread.

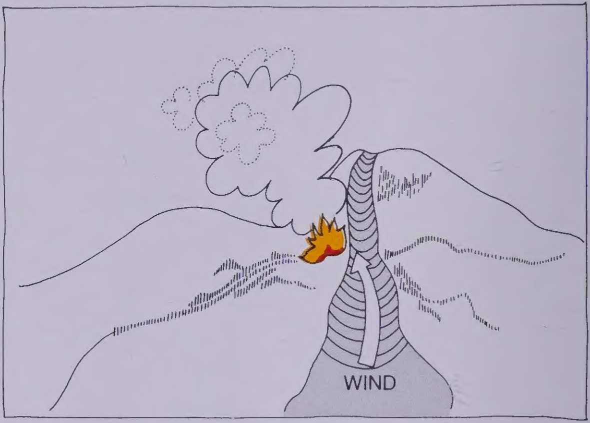
Terrain

Terrain or special land features may control wind flow in a relatively large area. Wind flows like water in a stream, and will try to follow the path of least resistance.

Ridges, trees, and rocks may alter wind flow and cause turbulence or eddies to form on the windward side of obstructions.

Also, when wind flows through a restriction, such as a narrow canyon, it will increase in strength.

Wind movement can be critical in chutes or steep v-drainages. These terrain features create a chimney effect, causing a forced draft, as in a stove chimney. Fires in these chutes or drainages spread quickly and are very dangerous.



DESCRIBING FIRE BEHAVIOUR

Successful fire-fighting is based on knowing why a fire burns and what makes it spread.

For example, sometimes the layout of fuel is more important than the amount of fuel. If fuels are patchy, the spread may be uneven and slow.

If these same fuels are partly on the ground and partly upright (snags), spread may be spotty and, with severe winds, cause a difficult fire.

It is important for the first crew member arriving at a fire to size it up and be able to give a detailed report on the size and possible outcome of the fire.

The following factors, as previously mentioned, influence fire behaviour and how this behaviour may change:

- fuels;
- weather; and
- topography.

It pays to look carefully at all conditions in sizing up a fire.

UNLESS A FOREST FIRE IS PROPERLY ANALYSED, PROPER SUPPRESSION CANNOT TAKE PLACE.

WHEN SIZING UP A FIRE, CONSIDER THE FOLLOWING FACTORS:

FUELS;
WEATHER; AND
TOPOGRAPHY.

Unless a forest fire is properly analysed at the first approach, proper suppression cannot take place.

FIRE SUPPRESSION

BASIC SUPPRESSION RULES

There are only three rules in suppressing a fire.

Fast Attack

Get organized and get your crew to the fire as fast as you safely can.

Aggressive Action

This is war. Hit hard and hit fast and keep the fire small.

Good Mop-up

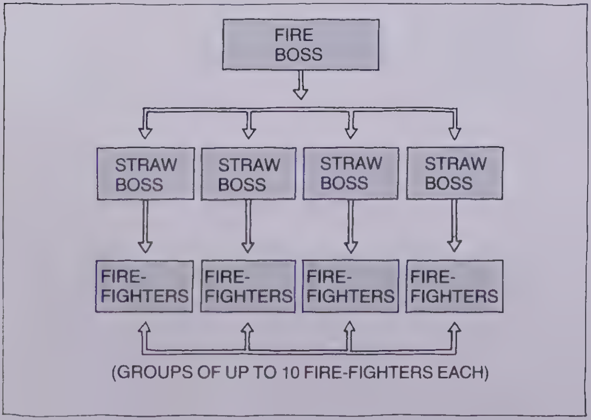
Stay in the fire area until the fire is out; dead.

CREW ORGANIZATION

All crews have the same basic organization no matter how many fire-fighters are involved.

Depending upon your job on the fireline, your immediate supervisor is known as the *straw boss*.

A crew basically breaks down like this:



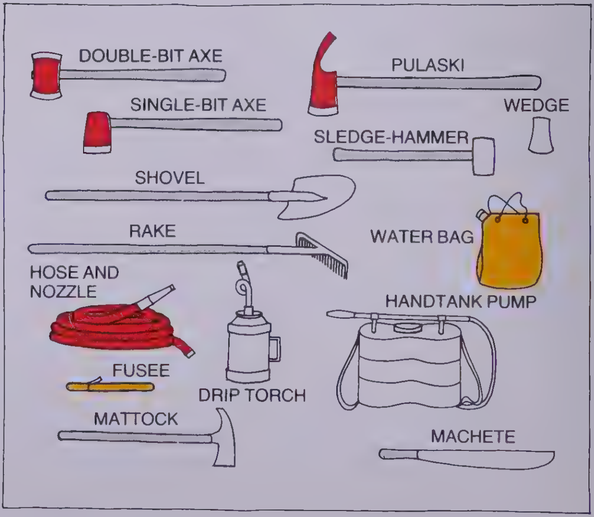
TOOLS AND PERSONAL GEAR

The most common hand tools used in fire suppression work in British Columbia:

- shovels;
- axes;
- mattocks;
- pulaski tools (combination axe mattocks);
- saws
- machetes;
- sandviks; and
- handtank pumps.

Other tools used include:

- drip torches;
- fusees;
- sledge-hammers;
- wedges;
- water bags and canvas pails; and
- rakes and steel brooms.



Each fire-fighter should have the following clothing and personal gear:

- hard hat;
- flannelette work shirt with long sleeves;
- sturdy, warm jacket to wear at night;
- tough jeans or work pants with no cuffs;
- heavy work boots with 6- or 8-inch tops and composition soles; and
- medium heavy wool socks to prevent blisters, plus one extra pair in case of wet feet.

All fire-fighting clothing must be made from natural fibres such as cotton or wool. These clothes are much more comfortable and less dangerous in fire-fighting conditions than synthetic blends. Synthetic materials such as nylon or dacron can aggravate injuries to the wearer if they catch fire.

HEAVY EQUIPMENT

Of course, fire-fighters have many resources available to them besides the basic hand tools. Often, on a large fire, heavy equipment is brought in.

Bulldozers

Bulldozers are used extensively for pushing a path through standing trees, building roads and fire-guards, and sometimes to attack small fires and literally bury them.

There are many safety considerations to be taken into account when operating or working around a bulldozer.

Every machine should have a metal canopy and roll-over protection to protect the operator.

No operator shift should exceed 10 hours.

All crew members working around a bulldozer should wear brightly coloured hard hats.

Never take a nap in the vicinity of a working bulldozer.

Never leave the machine running without lowering the blade and applying the brakes.

Never work below a bulldozer.

Helicopters

Helicopters may be used to sling in equipment along the fireline and for dropping water or retardant from sling buckets.

There are some basic rules to be followed when helicopters are being utilized:

- never stand directly beneath a helicopter;
- watch that the blades do not fan the fire, a helicopter can create a tremendous downdraft; and
- remember to clearly mark a cargo drop zone and stay out of that area until the helicopter has left.

Air Tankers

These planes come in several models and can carry anywhere from 600 to 2,000 gallons of retardant. They are very effective in fire-fighting, but fire-fighters can be killed or injured if they get caught in a drop area.

However, in most cases, you will be well warned to get out of the way. Your boss and the aircraft may be in radio contact and you will be told when the tanker is coming in for a drop. There are also other easy ways to know when to leave a target area.

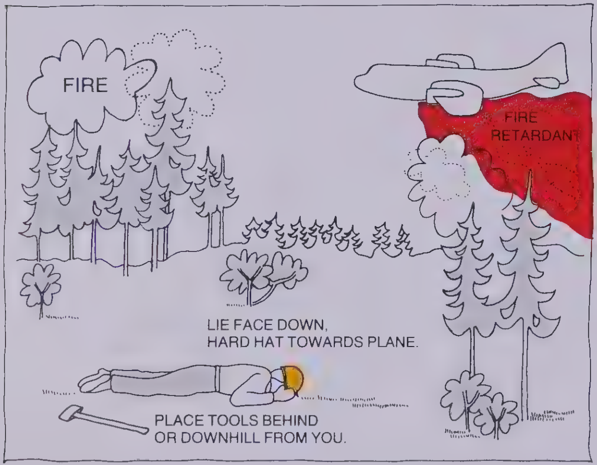
Air tankers are usually, but not always, preceded by a smaller lead plane over the drop zone. The bird-dog plane will make one pass before the drop.

If the tanker is alone, he will also make one pass before dropping.

To move safely out of the drop zone, walk, don't run, to a location at right angles to the drop path about 100 feet away from the target. Get clear of dead snags, rocks or other materials that may be dislodged by the drop, especially if you are downhill. Stay clear of powerlines and poles.

If you are caught by surprise in a drop zone, place your hand tools to the side, behind or downhill from your body. Lie on the ground, face down, hard hat on, with your body facing the approaching plane. Grasp something firm to prevent being carried or rolled around.

If you do get covered with retardant, clean it off and keep it out of your eyes.


FIRE
FIRE RETARDANT
LIE FACE DOWN, HARD HAT TOWARDS PLANE.
PLACE TOOLS BEHIND OR DOWNHILL FROM YOU.

Air tankers are an effective tool but an expensive one, and whether they work depends on the individual fire-fighters. Retardant dropped from an aircraft will rarely work on a fireline by itself, nor will it stop a hot moving fire. It will most likely be used on spot fires, small fires, and hot spots along the edge of larger fires in order to cool them down so that you, as a fire-fighter, can keep building the line. It is important that fire-fighters keep working after a retardant drop, because if a hot spot rekindles or the fire gets away, the drop was wasted.

SIZE-UP AND FIRST ATTACK

The person who arrives first or who is in charge of the first crew to arrive at the fire must size it up and decide on the point of first attack before effective work can be done.

A good fire-fighter will:

- note the exact time he arrives;
- make a quick size-up of the job;
- formulate a simple plan of attack and make sure that all his men know and understand the plan;
- select escape routes and make them known; and
- post a look-out if there is possible danger.

Size-up

Sizing up the fire can be done quickly. Walk around the fire edge if it is small, or get to a vantage point where you can see the entire edge. Remember that you are looking for:

- types of fuels;
- weather; and
- topography.

If there is evidence of a man-caused fire, make note of any suspicious activity in the area, take licence numbers or anything else that might help an investigator track down those responsible for the fire.

Now that you have determined what the problems are, and will be able to decide on the priorities and select the point of first attack, it is time to advise your dispatcher of arrival time, estimated fire size and the fire situation. Request help if you need it.

Attack

Now you are ready to get after the fire. The rule is: *attack the point where the fire is most likely to escape*.

There are three basic ways to attack: remember the fire triangle.

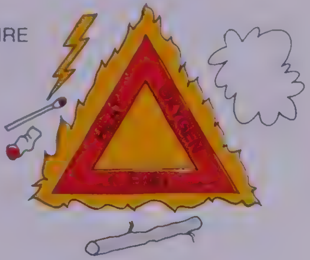
Remove the fuel. Cut a path between the fuel supply and the fire. This is a fireline.

Remove the air. Since there may be spot fires ahead of the fireline, fire-fighters should extinguish them by shovelling dirt.

Remove the heat. The most popular way is to apply water. Water should only be applied in emergency hot-spot control situations and then used sparingly as a short-term solution. You will seldom have enough water to completely extinguish a fire. Water, then, is usually used only to cool a fire and stop its spread. Action is not completed until fuel is removed from the path of the fire. This is accomplished by the construction of a fireline, down to the mineral soil.

THE FIRE TRIANGLE
HEAT + OXYGEN + FUEL = FIRE

THE BASIC RULE: REMOVE ONE SIDE OF THE TRIANGLE, AND THE TRIANGLE WILL COLLAPSE; COMBUSTION WILL CEASE AND THE FIRE WILL BE EXTINGUISHED.



ATTACK METHODS

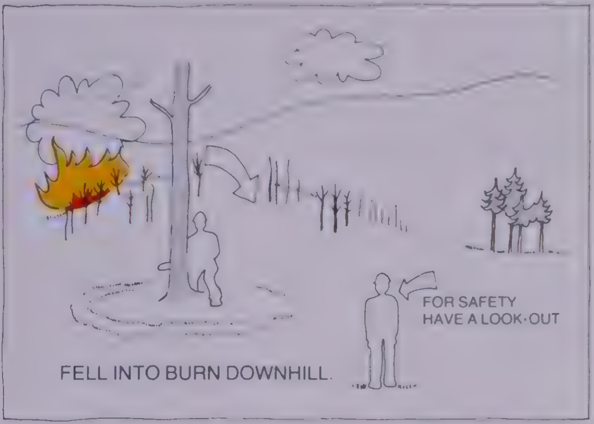
Take prompt action on the vital areas. Do not get bogged down at one place and let the fire escape. *Hot-spotting* means moving from one "hot spot" to another and making them safe as you go.

Start by cooling down hot spots with dirt or water if available. Then separate fuels, knock down low-hanging limbs, and create a narrow fireline around the hot spots.

Basic Principles

Remember spots may be more dangerous than the main fire; temporarily 'hot-spot' them. Use water or dirt.

Snags must be cut down if necessary to stop the fire spread. Watch for loose limbs and trees leaning against each other. If the snag is not on fire but in the immediate path of the fire, put a fireline around it to keep it from catching.


FOR SAFETY HAVE A LOOK-OUT
FELL INTO BURN DOWNHILL.

Low-hanging limbs may lead fires to the crowns. Cut them off and remove fuel from beneath the trees. Cut down and remove small trees that may candle.

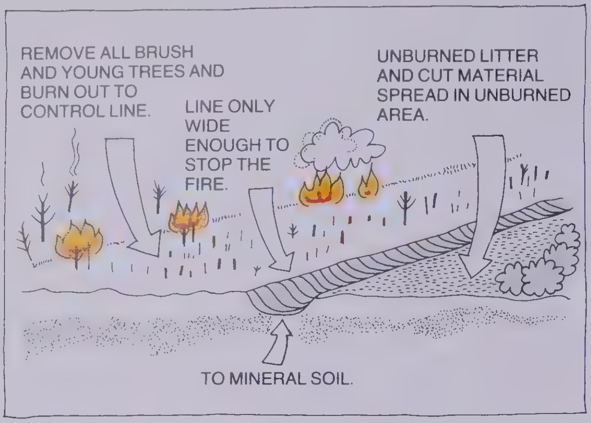
Grass or tree needles lead fire to heavy fuel. Throw dirt or spray water on the fire edge or scrape a narrow fireline immediately against the fire edge.

Logs and cones may roll and scatter fires. Turn logs to lie up and down the slope or block with rocks to prevent rolling away. Chip fire off the outside of logs. Shoestring a trench below logs and rolling cones. Roll logs out of hot coal beds to reduce burning.

Piles of limbs and logs cause high-intensity burning and may shoot flames and sparks high into the air. Separate piles, cool down with dirt, and shoestring fireline.

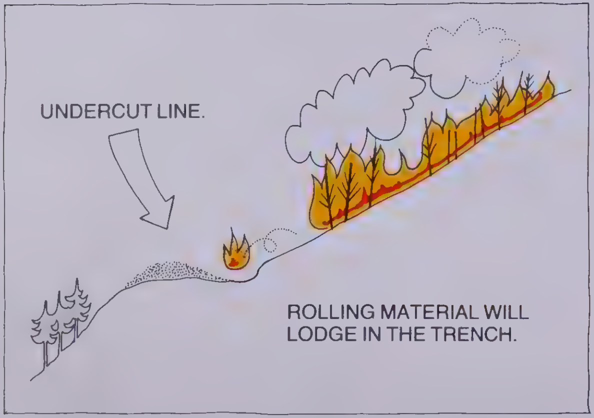
Constructing a Fireline

When you have cooled down all the dangerous places you are ready to construct a fireline. A fireline is used for separating the fuel from the fire, halting the fire's advance, and containing the fire within this line. This can be done by cutting, scraping or digging a trench wide enough to prevent a fire from smoldering, burning or spotting across and igniting the fuels on the other side.


REMOVE ALL BRUSH AND YOUNG TREES AND BURN OUT TO CONTROL LINE.
LINE ONLY WIDE ENOUGH TO STOP THE FIRE.
UNBURNED LITTER AND CUT MATERIAL SPREAD IN UNBURNED AREA.
TO MINERAL SOIL.

The fundamentals of fireline construction are:

- line width, depth, length and clearance.
- the line should only be wide enough and deep enough to keep the fire from crossing it; the width and depth will depend on the type of fuel, and the rate of spread;
- the depth in most cases will be down to the mineral soil;
- a fireline of some sort must encircle the entire fire for total control;
- a v-trench or roll trench must be provided on all underslung firelines where danger of rolling debris is present.



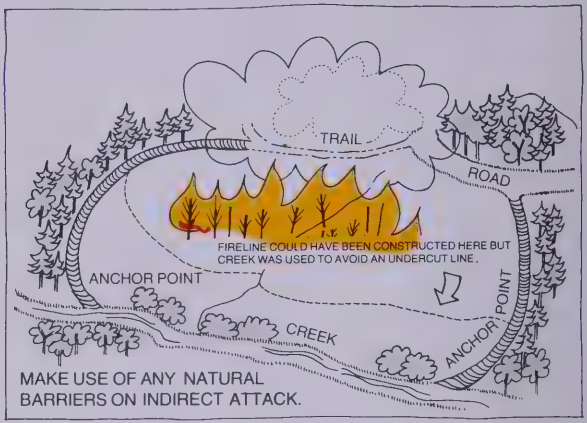
Parts of the fire to be controlled are:

- flank;
- head; and
- rear.

You either hit the head (point of most rapid spread) or start at the rear and work forward on both sides (flanks) at the fire edge and thus pinch out and control the head.

Line Location

If the fire is too hot and moving too fast to safely stop forward spread with the resources you have, locate a place to start the final control line. This should be along the edge of the fire where you can work safely.


TRAIL
ROAD
FIRELINE COULD HAVE BEEN CONSTRUCTED HERE BUT CREEK WAS USED TO AVOID AN UNDERCUT LINE.
ANCHOR POINT
CREEK
ANCHOR POINT
MAKE USE OF ANY NATURAL BARRIERS ON INDIRECT ATTACK.

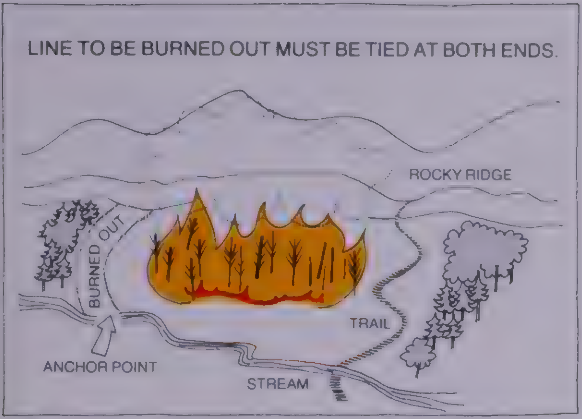
When selecting an *anchor point,* keep the following points in mind.

The safest spot to start from will normally be at the lowest point on the fire. This way, the fire cannot outflank you because there is no fire below you.

Many times there will be a natural or man-made barrier to start from.

Build your line from the anchor point, uphill along the flank, toward the head of the fire.

If you cannot get right on the edge because of the heat, build your line parallel to the edge, a few feet away. This is called *parallel line construction* and should be just far enough from the fire edge to enable crew members to work effectively. The line may be shortened by cutting across unburned fingers. Do not leave piles of limbs, low-hanging branches and other hazardous fuels next to the fireline. The intervening strip of unburned fuel is normally burned out as the control line proceeds, but may be allowed to burn out unassisted where this will occur without undue delay or threat to the line. A crew boss will normally do the burning out as a part of the line construction.



Principles of line location

Firelines should be located as close to the fire edge as possible. If you can build right on the fire edge without wasting time, that's your best bet. This is called a *direct line.*

If the fire is spreading too rapidly, the line will have to be located far enough from the edge to allow time for you to encircle it and burn out. This is an *indirect line.*

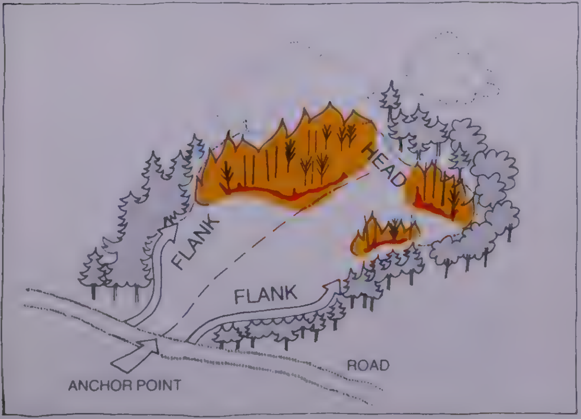
Firelines should be made as short as possible, although a line built right on the edge of the fire is best in some cases, even though it may be longer.

Existing natural barriers should be used where possible.

When possible, construct firelines through open areas rather than fight through dense or heavy fuels which can take much longer.

Avoid sharp angles.

Block off high-hazard fuels where possible by leaving them outside the fireline.



Lines should be located far enough from burning snags to enclose them when felled and to catch sparks.

Encircle areas of numerous spot fires if individual fireline construction around each spot fire is impractical.

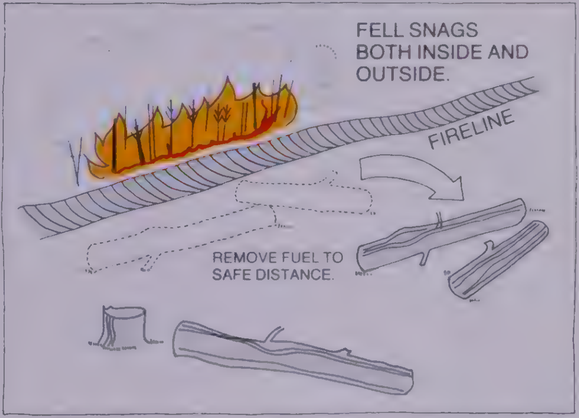
Use oblique lines to pinch off the head.

When possible, locate line to give an uphill start to burning out.

Take advantage of normal daily wind shifts.

Snags

Removal of *snags* is necessary where snags exist adjacent to the fireline. Old snags are dry and punkish, and in a general state of disintegration. One small spark will set them ablaze and they, in turn, will shower the countryside with sparks.


FELL SNAGS BOTH INSIDE AND OUTSIDE.
FIRELINE
REMOVE FUEL TO SAFE DISTANCE.

As operations proceed, cut down snags standing adjacent to, and on both sides of, the control line for a distance of 200 to 300 feet on the fire side of the line and for a distance of 50 feet on the opposite side of the line. The distance to which snags are to be felled increases with the height of the snags, their elevation above the fireline level, and the degree to which they are exposed to wind.

Fires have been lost because snags have not been felled on both sides of the line. If speed is essential or if snags are so situated that felling is not possible, the fuel around the base of each snag inside the line should be cleared and scattered. This is called ringing a snag.

Rules of Line Construction

On the flank of a fire spreading in needles, scrape a 6- to 8-inch line to mineral soil.

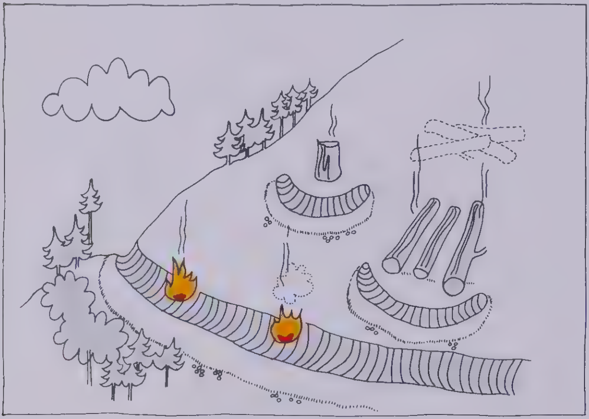
On the head of a fire on a steep slope, in open timber with some down logs and light bush, a clearing at 3 to 4 feet will generally do the trick.

Clearing should be about the same width as the height of the surrounding burning fuel.

Dig a v-trench to catch rolling fuel.

Turn logs and chunks parallel with the slope to keep them from rolling.

Place spotters at high strategic points to be on the lookout for spot fires and fast-running fingers from the main fire. Be prepared to put out spot fires before they get large.



Line Strategy

Attack first where the fire is most likely to get away.

ATTACK FIRST WHERE THE FIRE IS MOST LIKELY TO GET AWAY.

In dense brush or timber, if the fire is too hot to attack head on, flanking action should be taken from a safety view point.

Hot-spot or hit vital points of spread first.

Fell all trees and snags away from the line.

Fell or clear rings around snags.

Watch for spot fires and extinguish them fast.

Make use of any natural barriers.

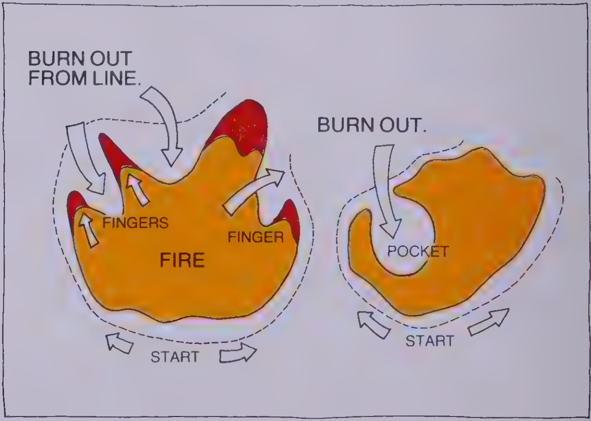
Tie in the whole perimeter.

Burning Off

Before any fire-guard can be considered completed, it must be *burned off.*

How to burn off

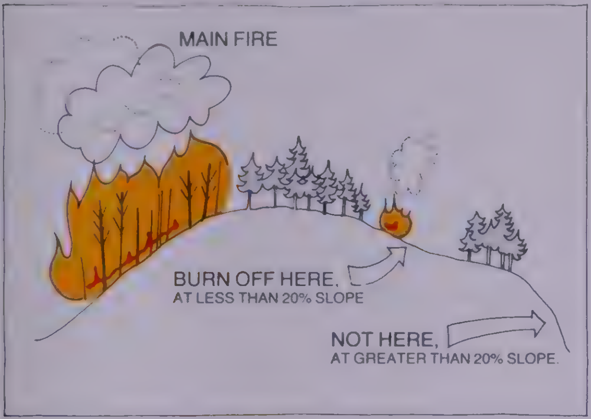
After the control lines are established at strategic places in advance of the fire, the burn-off fires are started. These control lines should include roads, ridges, creeks, or other existing breaks, with the thought that burning off is to be started from them. The lines are to be as straight as possible and in such a location (taking into consideration draft, wind, slope, fuel, etc.) that a good burn will be safely achieved, insuring control of the main fire.



The Purpose of Burning Out

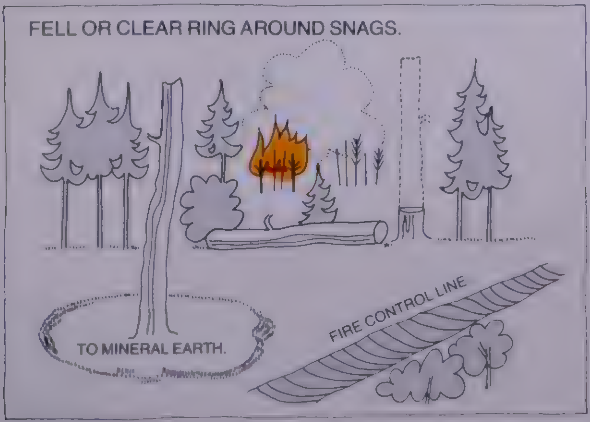
This is a method of widening the control line and cleaning up unburned pockets or segments of fuel extending to the line from the fire edge. *Burning out the intervening strip* between the fireline and fire edge is for the safety of the line. This is used on small strips or larger areas abutting the control line. Backfiring applies this method in a more extreme way to control the fire. It is fighting fire with fire. It is the main tool with which the fire is stopped by indirect method of attack.

Burn all vegetation. Either cut or cold-trail all islands, peninsulas or brush that won't burn. Start burning off when the time is right, slightly below the top of a hill or ridge and on the opposite side from the main fire. Do not do this on slopes steeper than 20 per cent, since deeply cut lines would be required to hold hot rolling fuel. On slopes steeper than 20 per cent, back up to the ridge top, or to where the slope is less than 20%, the draft from the main fire will cause a suction effect on the burn-off fire, insuring a good burn.



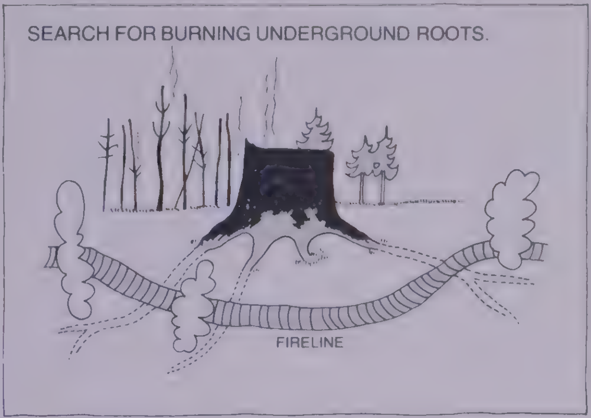
MOP-UP

The mop-up state occurs after a fire, or any part of a fire, is controlled and before suppression work is reduced to patrol and inspection. Mopping up makes a fire safe by extinguishing or removing burning and hazardous material, including snags along or near the control line.


FELL OR CLEAR RING AROUND SNAGS.

The following tasks must be accomplished:

- extinguish all smoldering material along the fire edge after the spread has been stopped;
- put all rolling fuel so it cannot roll across the line or trench below it;
- make sure that all burning fuel either burns itself out or is spread or buried to stop spark travel;
- clear the line on both sides of all special threats such as snags, rotten logs, stumps, singed brush, and low-hanging limbs of trees;
- search for underground burning roots near the line;


SEARCH FOR BURNING UNDERGROUND ROOTS.

- cover yourself for the worst possible conditions on a fire by mopping up all material adjacent to the line on large fires to make sure the fire cannot blow, spot, or roll over the control line;
- watch out for smoldering spot fires across the line in front of the main head of the fire;
- fell all burning snags into the burn in such a position that they will not roll or slide down the hill; if a snag has a lean that does not permit it to be felled either up or down the hill, clear the fuel away from where it will fall, roll, or slide, then fell it;
- when a snag is burning at the base, slow down the blaze with dirt or water, scrape out the burning part, then clear or dig a safety fireline around the area in which burning material has rolled.

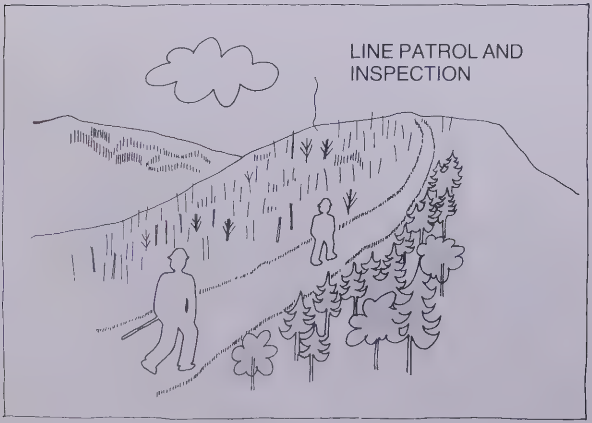
INSPECTION AND PATROL

Once a fire is controlled and mopped up, the fire boss will declare the fire to be "on a patrol" basis.

The job of the fire patrol is to walk the control line to prevent escapes, discover and control spot fires, and mop-up whenever necessary.

A fire patrolman will also keep a sharp lookout for "sleepers". Sleepers should be spotted before they have a chance to ignite the adjacent fuel and cause fire escape.

A sleeper is a hidden fire, deep inside the duff layer, or in a root tip. It is probably transferring heat along the root, or through the duff. As well, there is no glowing stage. The "sleeper" is aptly named. It may take up to three weeks before an adjacent patch of fuel is brought up to ignition temperature. Until then, it normally defies detection.



Patrol and inspection may continue for days or weeks. The importance of adequate patrol and inspection cannot be over-emphasized. To have a fire that has been controlled and apparently mopped up start anew—hours, days, or weeks later—can only be classed as an inexcusable failure.

SAFETY

Fighting fire is a hazardous occupation. It demands the highest efficiency and a good attitude at all times. The first responsibility of all fire-fighters is to take every precaution to prevent injury to themselves and others.

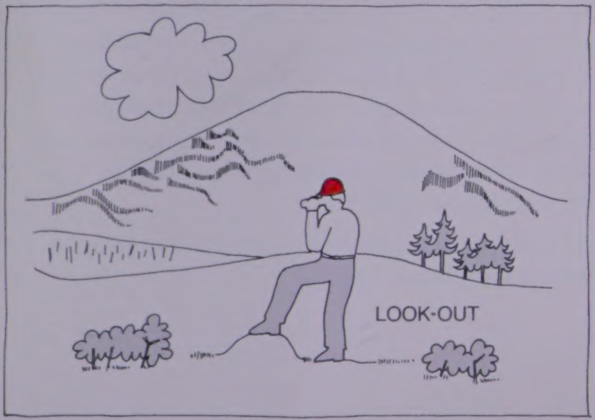
Because safety on the job cannot be overstressed, this section is specially written to handle safety in a variety of fire-fighting situations.

RESPONSIBILITIES OF A CREW BOSS

The two main responsibilities of the crew boss are to get a good day's work from the crew, and to look after their safety and welfare 24 hours a day.

The crew boss must be alert.

Know where the fire is at all times and what it is doing. Post look-outs if necessary.



Keep an up-to-the-minute escape route in mind.

Know how to handle the crew. Know what danger signs to look for, including fatigue. Know when to take a break.

The crew boss must think before acting and then act with decision.

The crew boss must have a good working team.

Know where all crew members are.

Use action words:

- "come here";
- "follow me"; and
- "keep together".

Never assume anything.

Assign the most experienced crew members to the key positions.

Keep the crew informed of all activity and progress.

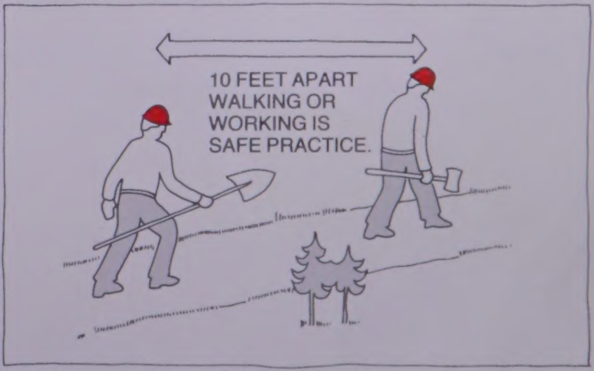
RULES OF A FIRELINE

When working on a fireline, the following rules should always be followed.

Stay with the crew boss and follow all instructions.

Stay at least 10 feet apart in single file when hiking in or out of a fire.

Work at least 10 feet apart.



Watch where you're walking.

Never walk or work beneath a burning snag.

Watch for rolling rocks on steep slopes.

Never work below a cat or another crew.

If you see something dangerous happening, shout out and warn your crew.

Give the alarm if the fire jumps the line.

Follow the WATCH OUT guidelines:

WEATHER	Dominates fire behaviour, so keep informed.
ACTION	Must be based on current and expected fire behaviour.
TRY OUT	At least two safe escape routes.
COMMUNICATIONS	Should be maintained with crew, boss and adjoining forces
HAZARDS	Watch for flash fuels, chimneys and snags.
OBSERVE	Changes in wind direction, velocity, humidity, and clouds.
UNDERSTAND	Your instructions and make sure yours are understood.
THINK	Clearly, be alert, and act decisively before your situation becomes critical.

DANGEROUS OR "BLOW-UP" CONDITIONS

Occasionally, a forest fire goes out of control. This is called a *blow-up* and it's a pretty serious situation. It can be caused by unusually fast- or dry-burning fuels or an extreme change in weather conditions such as sudden changes in the direction and the strength of wind when a weather front moves in. In such a case, the safety of the crew is paramount. The crew boss must always have an escape route in mind for blow-ups.

One of the safest spots is a burned-over area. If needed, dig in.

When there is no access to a burned-out area, remember that you can travel faster downhill or along the hill.

Do not travel ahead of the fire in the direction of the spread. It is almost impossible to out-run a fire.

In any brush fire, when working in advance with a cat, build a safety strip for retreat.

In timber, sharp ridges are the best bet.

When working in extreme conditions, maintain radio contact with the base at all times.

AIR SUPPORT

*Air support is a valuable tool for the fire-fighter, but it can be dangerous to you on the fireline. Remember, that the bird-dog aircraft makes at least one pass before the air tanker makes his drop. Keep out of the way of the drop area and clear out any branch or snag that could be broken in the drop.

Always stay out from underneath a helicopter with a sling load.

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